Decision Support System

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Introduction and Objectives

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What is the OPTIMAI Decision support system?

The OPTIMAI Decision support system:

› Supports you and other types of actors on the shop floor in your daily work;

› Has an **interface** that is **personalized** and **adapted** to your work context, preferences and behaviour;

› Notifies you about the **detection of defects, anomalies** and **suboptimal machinery operation** in manufacturing processes;

› Is available on **multiple devices** (AR glasses, tablet and PC), and sends you system notifications on the most convenient device based on your context; This training module refers to the PC and tablet interfaces;

› Is **easy to use** and **easy to learn how to use** thanks to its simple and intuitive design;

› Allows you to perform complex tasks in an optimal way;

› Improves **end-user decision-making** and provides **notifications** for predictive maintenance actions based on early detection of defects or prediction of upcoming malfunctions.

Who is this module aimed at?

› The **primary audience** is the end-users at the OPTIMAI pilot sites: operators, technicians, engineers, production managers and production specialists at KLEEMANN, TELEVES and MICROCHIP.

› **Secondary audiences** include other OPTIMAI partners and external stakeholders interested in novel shop floor applications designed to improve efficiency and decision making in the production chain. Industry 4.0 actors representing manufacturing and other fields will be interested, as well as actors from e.g. the health care, automotive and aerospace sectors.

What is the purpose of this module?

In this module, you will learn about the following aspects of the Decision Support System (DSS):

› The **interface** displayed on your PC or tablet depending on what device you use;

› **What** information is displayed;

› **How** the information is presented;

› **How** you can **navigate** and **interact** with the system.

At the end of this training course, you will be able to:

1 › Use the Decision Support System (DSS) interfaces on the shop floor, through the OPTIMAI web platform on your device; PC and/or tablet.

2 › Perform key activities to enhance your productivity and confidence in the workspace:

a) **Monitor** in real-time the performance of key performance indicators (KPIs) in the pilot production line, in order to be able to respond accordingly.

b) Execute **defect detection** on the produced products through the OPTIMAI platform e.g. PCBs (MICROCHIP), antennas (TELEVES), quickly with increased accuracy, accompanied with some basic analysis of the quality control results (numeric values, totals, score etc.).

c) Perform **defect analysis** to observe values and correlations of measurements monitored in the production line, that will help you understand possible causes of defects that are unclear or difficult to observe because their impact is only visible through time and not in an instance. The analysis will support you to make more time-consuming decisions for the production planning.

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At the end of this training course, you will be able to:

2 Perform key activities continued:

d) Be **notified** about upcoming and detected defects and suboptimal operations of the machinery/robots/sensors etc. of the pilot production line. You will be able to be notified when an event occurs, and make immediate decisions for control actions, defect mitigation measures and defect propagation avoidance. Additionally, you will have access to the history of the **events** to observe possible patterns trough filters (date/time, industrial process, industrial asset etc.) that require more thought for medium and long-term measures.

e) Register and manage products and respective defects, as well as assets and measurements in the production line though the **administration** menu item. As a verified user, you will be able to add a new type of product when enters the production line, in order to be able to execute the quality inspection through the system or monitor the industrial processes of its production. You can also add or remove assets e.g., machinery, sensors, robots etc., based on changes that have been conducted in the pilot production line.

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Decision Support System - Functionalities & Visualization

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The menu items of the OPTIMAI web platform and the notifications layout

Users and access

› **Users:**

  › Monitoring and notifications/events are mainly addressed to **operators that execute tasks in industrial processes** that are being executed in the pilot production lines. The ones that need to and are verified to make control actions in the production line, responding to the observed industrial behaviors of machinery, sensors etc.

  › Defect detection is mainly addressed to the **quality control operators** in the pilot production lines. For each industrial process in the same production line e.g., glue/epoxy dispensing and wafer sawing there is a different view on the web platform (MICROCHIP).

  › Defect analysis, which supports more time-consuming decisions, is addressed mainly to the **production manager** or the person(s) responsible for the production planning.

  › Administration is addressed to the **production manager** or the person(s) responsible for declaring new products or new assets e.g., sensors, machinery, equipment, robots etc. in the pilot production line.

› **Access:**

  › All verified users in the shop floor can use the system, according to the end-user's requirements and the defined access rights.

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The ABC of defect detection

In the defect detection function, you can select the industrial process that you want to run the inspection for.

› For example, in MICROCHIP, you can carry out defect detection in three operations:
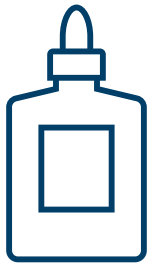
Glue/epoxy dispensing

PCB routing

Wafer sawing

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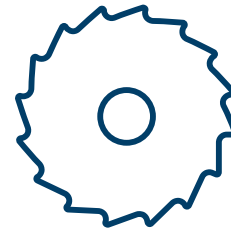
The ABC of defect detection

› To start, press the quality inspection button. The system will communicate with the Middleware to fetch the quality inspection results (.json and image).

› You will receive feedback about the progress of this process via a progress bar accompanied by relevant messages. You will be informed in case of an unexpected error or if the process is interrupted.

The ABC of defect detection

1 › For the glue/epoxy dispensing process for a PCB quality inspection, **press the quality inspection button.**

2 › **Receive feedback** about the progress of the process in the message area and in case of an unexpected error; if the process is interrupted etc.

3 › Once the process is completed you will receive the **quality inspection results** on the right.

Defect detection in MICROCHIP glue/epoxy dispensing operation

The ABC of defect detection

› The results are displayed on the image and the overlay colour coded indicators:

       › green for normal,

       › yellow for acceptable, and

       › red for defective glue areas.

› **Defective** means that they cannot pass the quality control. Defective areas are areas with insufficient or excessive glue volume.

› **Acceptable** are either insufficient or excessive but the amount of glue is acceptable to pass the quality control.

› The user, by default, views all the indicators but can **uncheck/check** to view them according to preferences.

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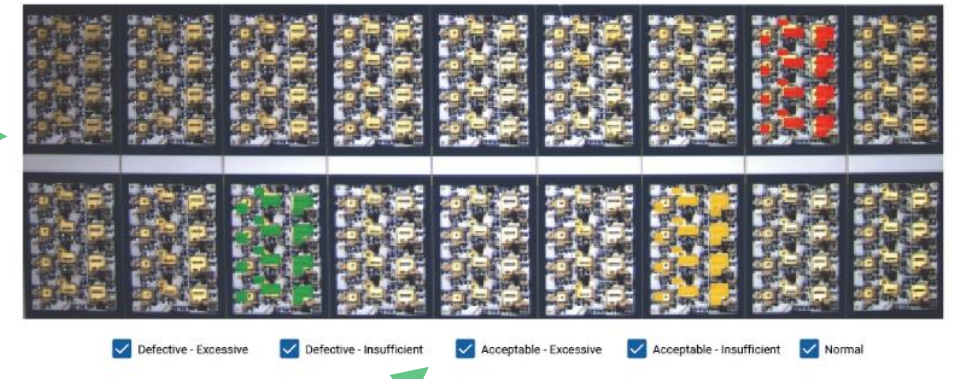
Basic analysis of the results displays

› i) the **overall score** of the PCB: if the PCB is a scrap, acceptable etc. considering the total status. In this widget mitigation/responding actions can also be displayed according to the overall score.

› ii) the **numeric details**: the amount of glue areas detected per status (defective - insufficient and excessive, acceptable - insufficient and excessive, normal).

Basic analysis of the results displays

› There is an additional widget that displays **events** coming either for the defect detection, or the defect prediction, related to the batch currently being inspected.

› For example, if during the inspection process 2-3 PCBs in a row are characterized as acceptable, there is a high probability of coming across a defective PCB shortly.

› The probability will increase if the number of the sequential acceptable PCBs is increasing.

› Additionally, events related to the defect detection process also are being displayed in this widget, with chronological order. Each time the system detects such events, informs the user in the AI upcoming defects & defect detection notification area.

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Monitoring

› You will be able to register measurements through the administration option.

› You will then be able to select the relevant devices, sensors, machinery, robotic cells equipment and robots and the corresponding measurements.

› For each of the measurements, you may select a visualization option e.g.:

Line graph   **pie chart**   **bar chart, etc.**

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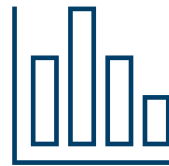
You carry out the monitoring separately for each process:

› dispensing,

› PCB routing,

› wafer sawing.

› This is reflected in the three different tabs at the top.

› Green and red indicate normal and abnormal values respectively.

Wafer sawing monitoring results

Monitoring: TELEVES

You can capture monitoring measurements from the production line e.g. robotic cells.

This includes:

› Live numeric values monitored in the production line visualized in graphs.

› Also numeric values from defect detection and prediction e.g. number of defects detected the last 15 min, the percentage of successful termination of defect propagation etc.
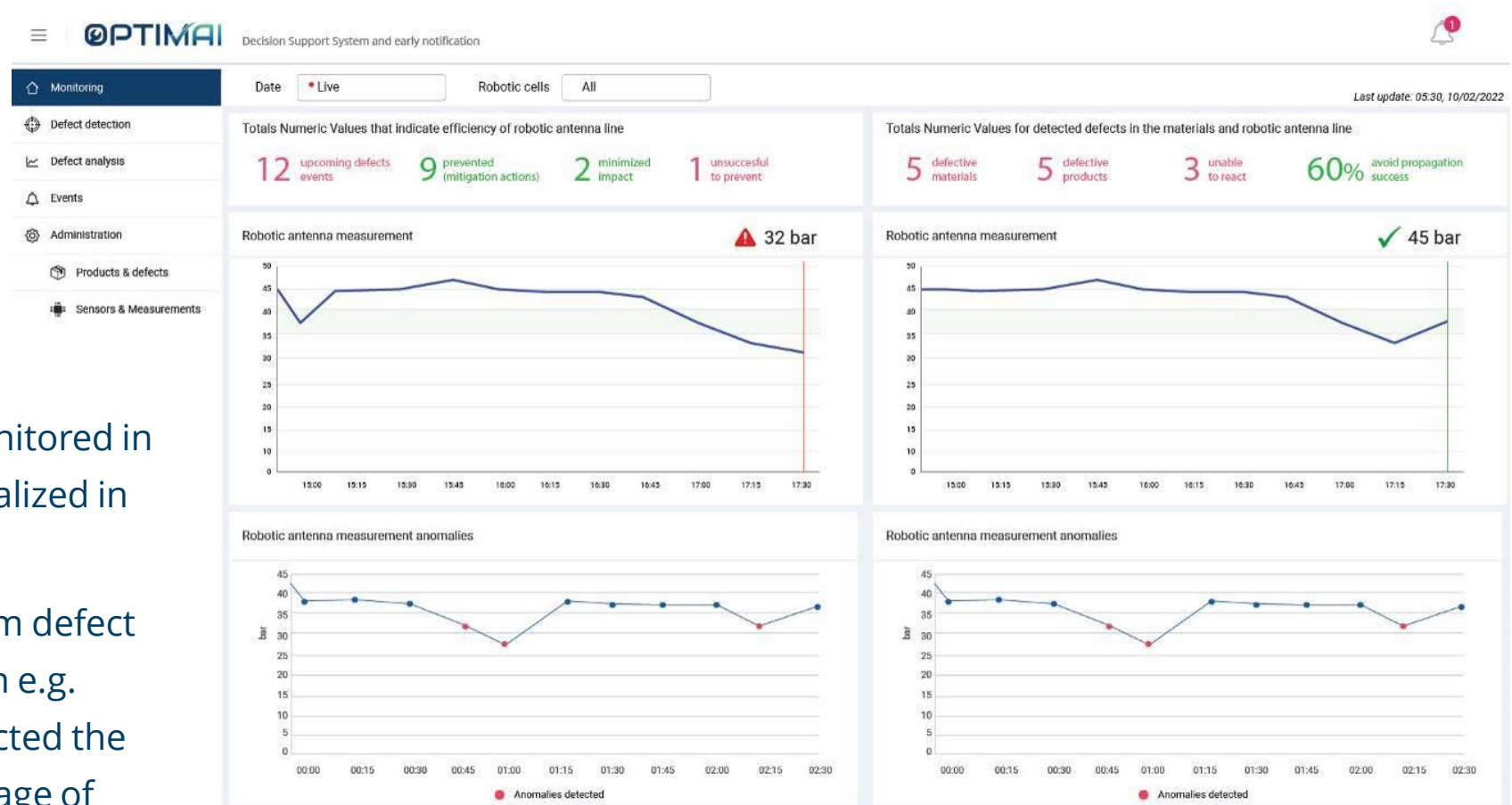
Monitoring: KLEEMANN

› You can monitor the following measurements from the power unit testing, during the Hydraulic power unit quality inspection:

  › velocity,

  › sound and

  › pressure of the lift,

  › vibration and

  › valve block pressure.
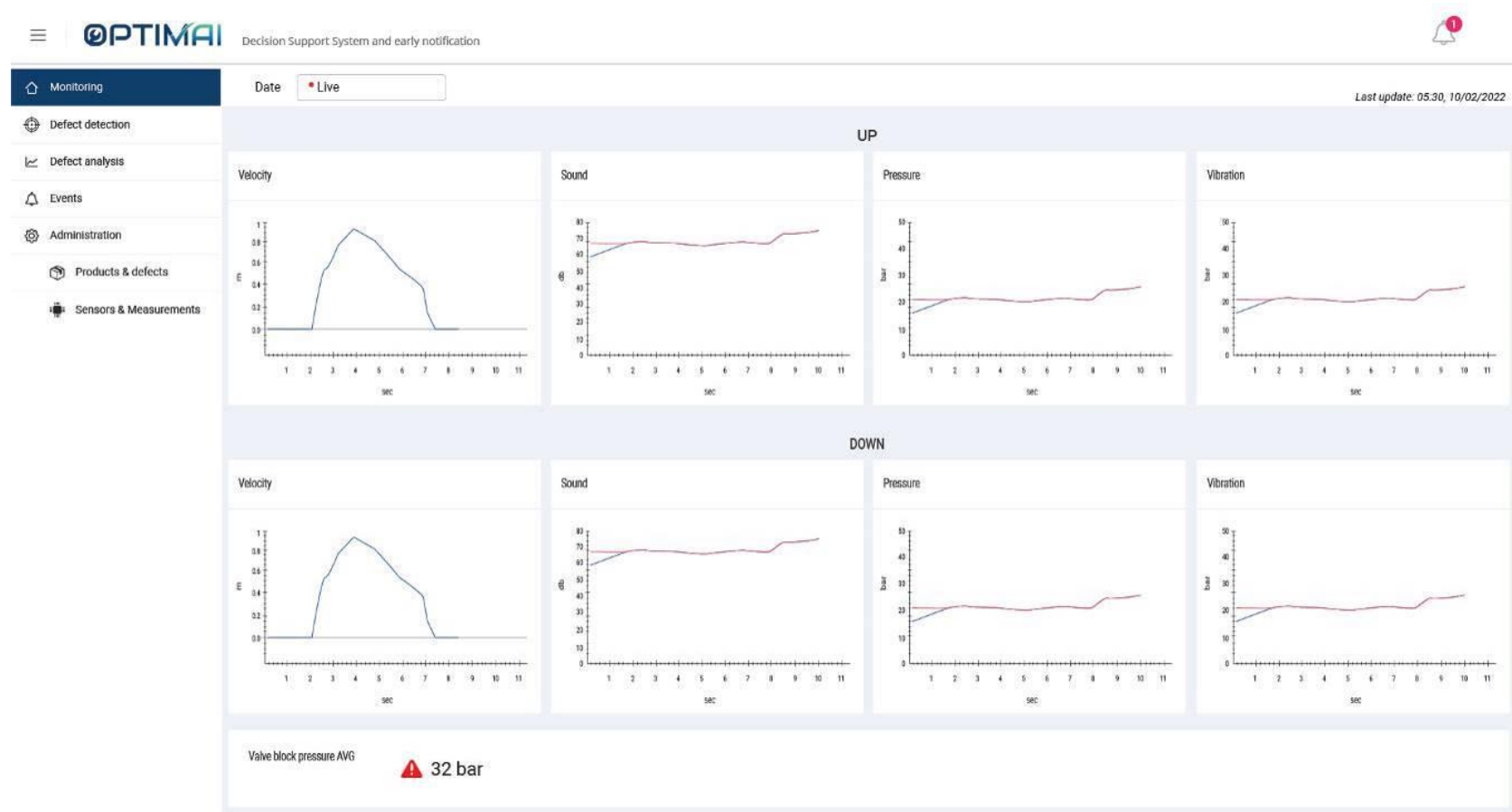
Defect analysis

› The defect analysis shows you the aggregated information from the quality control including detected and upcoming defects.

› It also shows the detected and upcoming measurement anomalies that indicate suboptimal operation.

› You can retrieve historical data based on the time window you select in the date picker. The date picker will include a calendar for the selection from/to date and quick selections such as today, this week, this month, this year.

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Defect analysis: MICROCHIP

› You will see the defect analysis by operation: dispensing, PCB routing, wafer sawing.

› Indicatively, you are informed about the defective PCBs detected per defect type, anomalies detected in PCB production measurements, and the glue/epoxy inspection results (normal, insufficient, excessive).
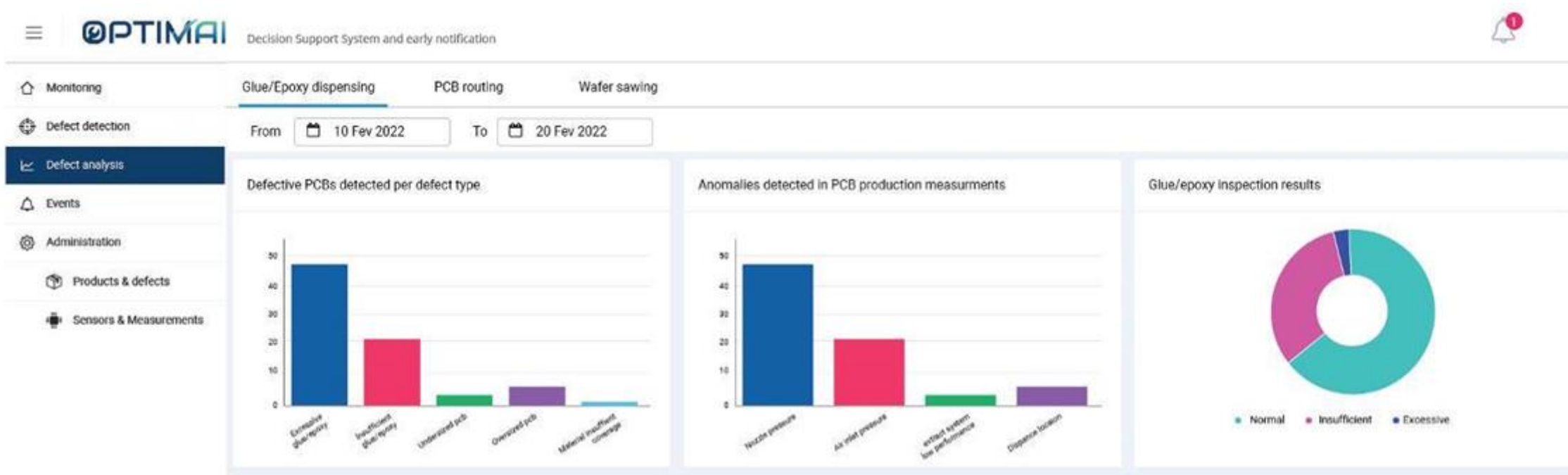
Defect analysis: TELEVES

› You can conduct the defect analysis per robotic cell.

› You receive the details about suboptimal operations in the robotic line in an aggregated way based on the timeframe you have selected.
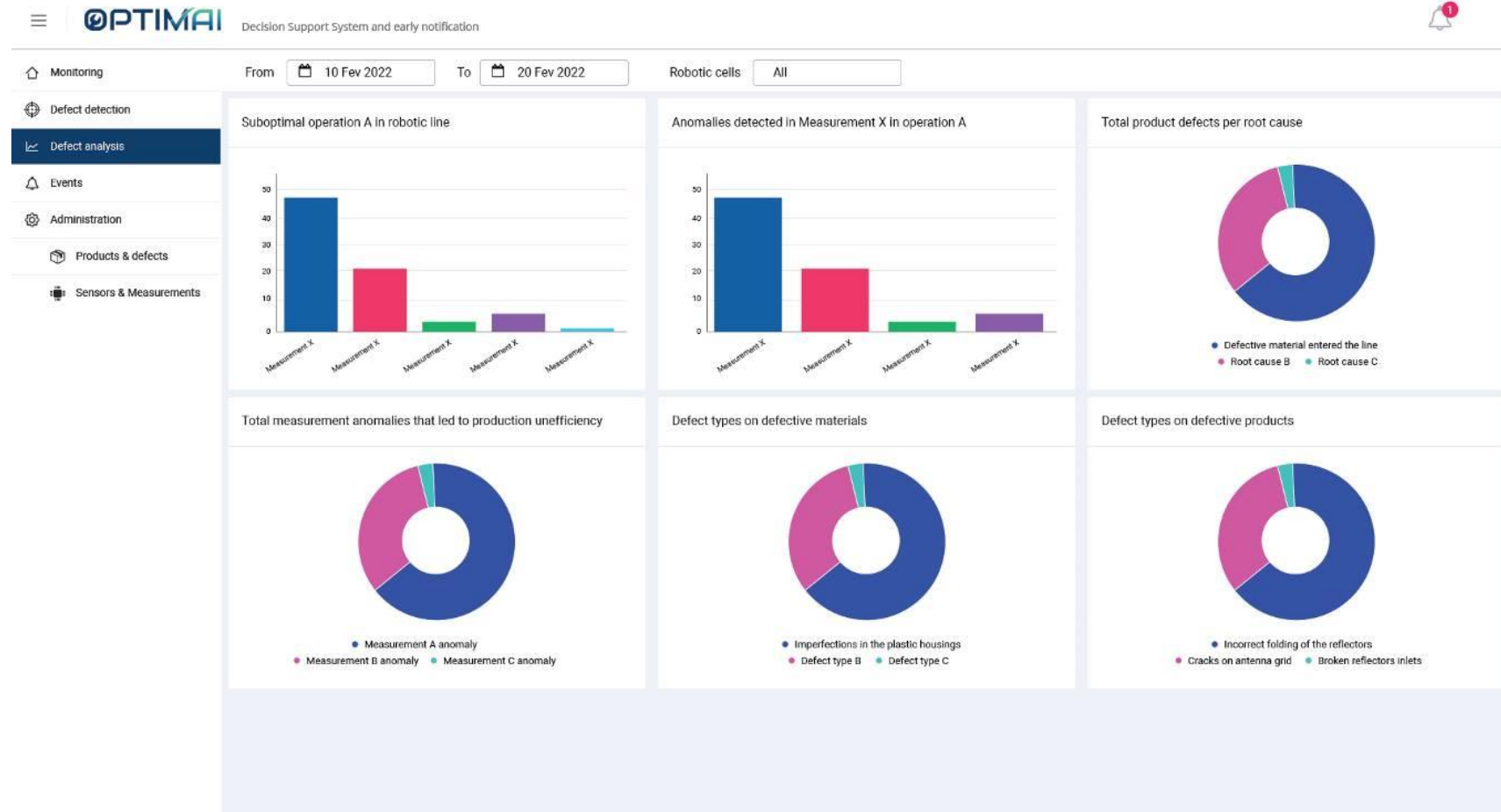
Defect analysis: KLEEMANN

› The analysed defects include:

  › the detected mismatches of parts in the power unit during the first phase of hydraulic power unit quality inspection;

  › the anomalies detected during the second inspection process, the testing of the lift during up and down operations.

› In the corresponding widget, you can select the measurement e.g.:

  › velocity,   › pressure,

  › sound,   › vibration.
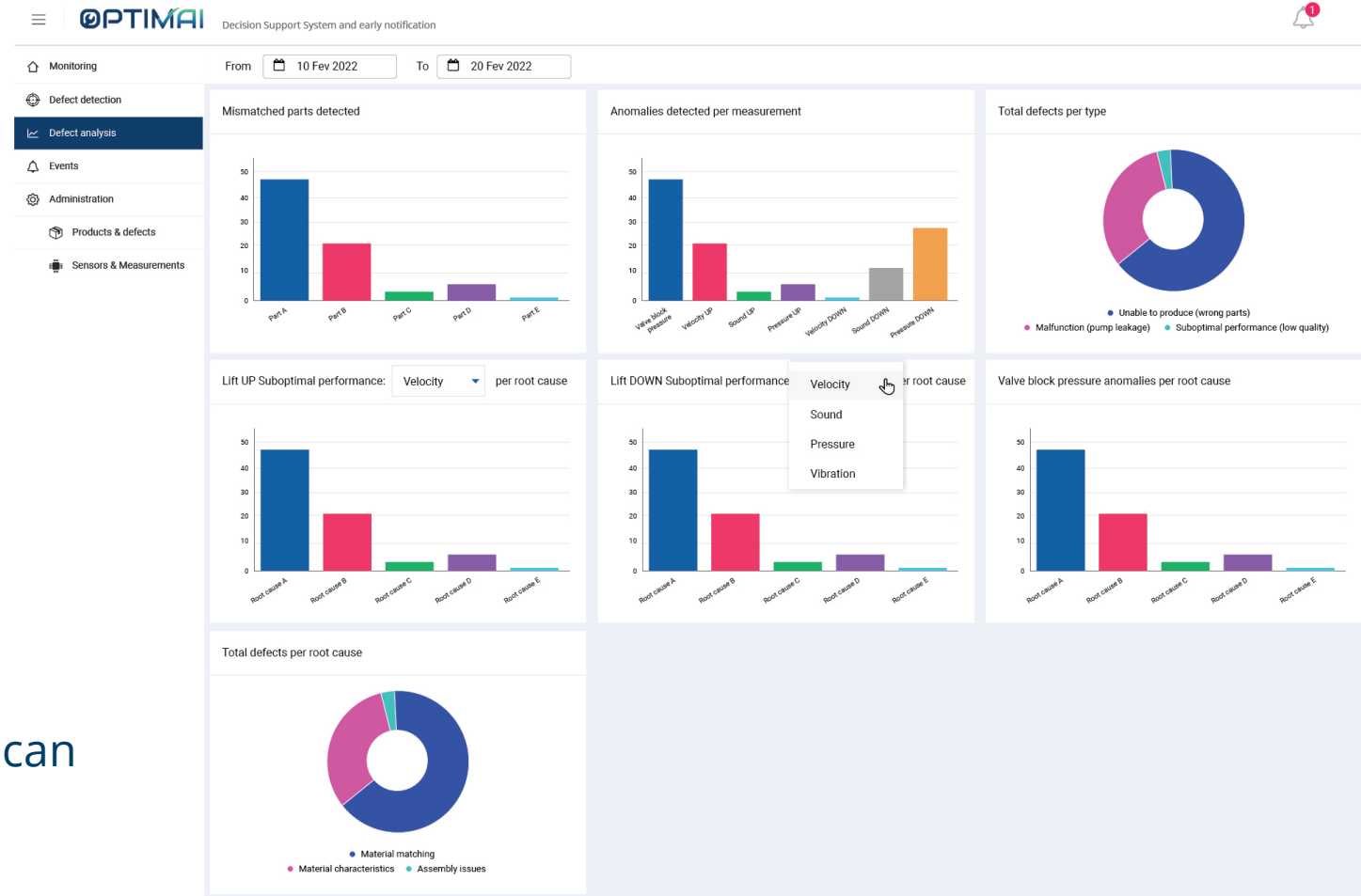
Notifications/events

› At the bell icon you receive the notification events in (near) real time, while the past events that triggered notifications are accessible to the events menu for you to retrieve at any time.

› The notifications are colour-coded based on their severity level:

 › **Yellow:** informative is the notification that does not require any action e.g., an automation that the system executed,

  › **Orange**: the notification that needs attention, the system suspects that something is wrong but does not know exactly what is going on to provide specific recommendation. Thus, you should inspect something and draw a conclusion,

  › **Red:** the critical notification, where you should immediately do something to resolve an issue.

› The notifications that provide recommendations for mitigation action will be displayed in the operator's AR glasses for instant reaction, but in the cross-platform application the production manager can also be notified.

# Notifications

› Notifications in cross-platform application
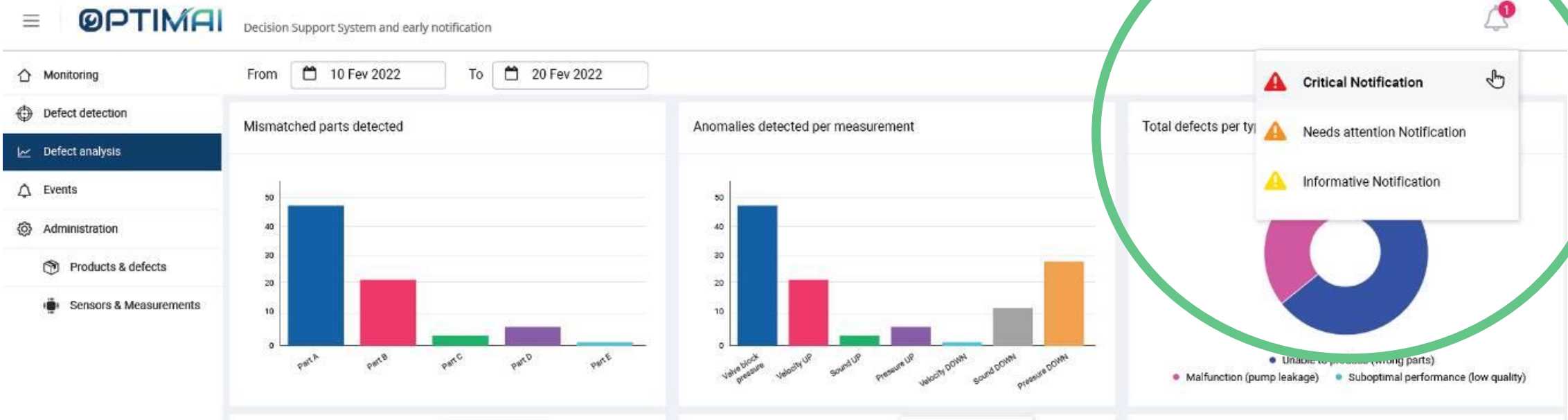
Beyond OPTIMAI pilot production lines

› The aim of the OPTIMAI technologies and the corresponding interfaces is to allow the expandability of the system and its transferability to other settings (e.g. new product type, other/altered production line, other production line, other products, other factory etc.).

› On the web OPTIMAI platform, the administration menu item, and the overall layout is designed for a generic DSS that can be used up to some extend to other settings. The identification of the exact limitations and possibilities of the web platform regarding expandability is an ongoing process.

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Generic decision support system

› OPTIMAI provides a generic decision support system that supports operators in different factories and that can be applied to all three pilot sites and a wide range of industrial settings at the end of the project.

› The system will allow users to register different types of products and corresponding known defects. This functionality will be expanded with new types of defects derived from the OPTIMAI system use.
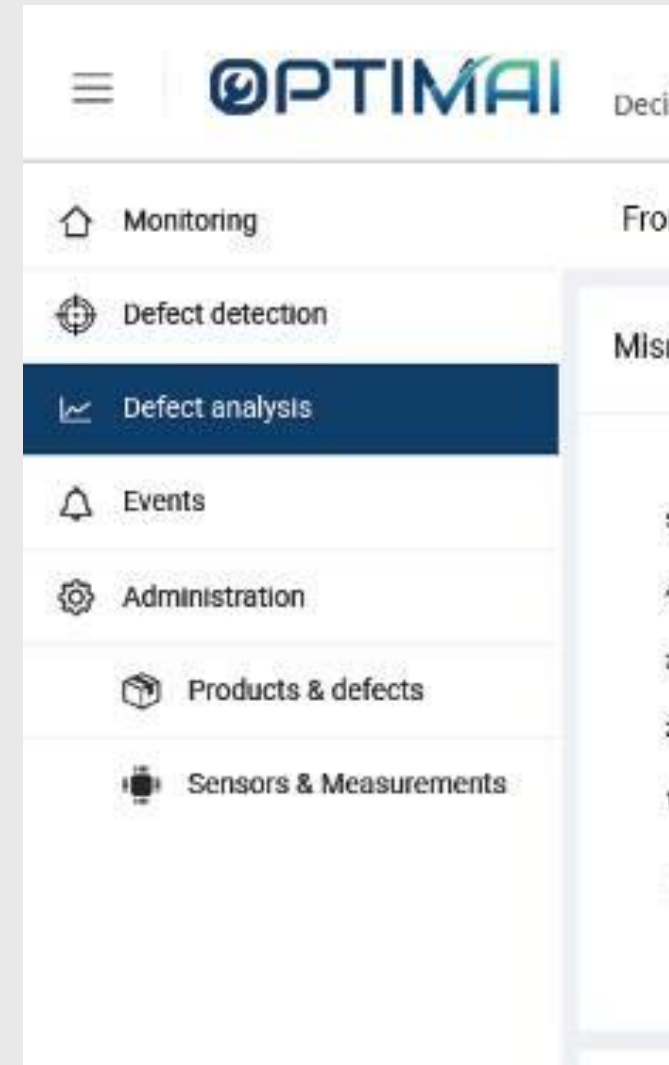
Next Steps

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Next steps

› The training material will be enriched as the project progresses.

› As an end-user, you will be involved in an intermediate testing of the platform which will take place during the next six months - at least one testing for each pilot site. This will ensure that the system serves its specific intended use.

› So far, your involvement in the design process of the web platform (co-creation workshops) has been valuable. This has allowed you to familiarize yourself with the tools, and the technical partners have been receiving your feedback to adjust.

› As an end user, you play a key role in implementing the decision support and early notification system, as it facilitates your decision-making process, leading to a significantly reduced production time and improved production quality.

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Thank you!

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